

Citation for published version:

Cumming, S, Brown, D, Mitchell, S, Bunce, J, Hunt, D, Hedges, C, Crane, G, Gross, A, Scott, S, Franklin, E, Breakspear, D, Dennison, L, White, P, Cain, A, Eisenmann, J & Malina, RM 2018, 'Premier League Academy soccer players' experiences of competing in a tournament bio-banded for biological maturation', *Journal of Sports Sciences*, vol. 36, no. 7, pp. 757-765. <https://doi.org/10.1080/02640414.2017.1340656>

DOI:

[10.1080/02640414.2017.1340656](https://doi.org/10.1080/02640414.2017.1340656)

Publication date:

2018

Document Version

Peer reviewed version

[Link to publication](#)

This is an Accepted Manuscript of an article published by Taylor & Francis in *Journal of Sports Sciences* on 19 Jun 2017, available online: <http://www.tandfonline.com/10.1080/02640414.2017.1340656>

University of Bath

Alternative formats

If you require this document in an alternative format, please contact:
openaccess@bath.ac.uk

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Title: Premier League Academy Soccer Players' Experiences of Competing in a Tournament
Bio-banded for Biological Maturation

Authors: Sean P. Cumming¹, Daniel J. Brown¹, Siobhan Mitchell ¹, James Bunce², Dan Hunt³, Chris Hedges⁴, Gregory Crane⁴, Aleks Gross⁵, Sam Scott⁵, Ed Franklin⁶, Dave Breakspear⁶, Luke Dennison⁷, Paul White⁸, Andrew Cain⁸, Joey C Eisenmann⁹, & Robert, M. Malina¹⁰.

¹ Department for Health, University of Bath, Bath, UK

² US Soccer Federation, Chicago, USA

³ British Ski and Snowboard, London, UK

⁴Norwich City Football Club.

⁵ Southampton Football Club.

⁶ Reading Football Club

⁷ Manchester City Football Club

⁸ Stoke City Football Club

⁹Department of Radiology, Michigan State University, East Lansing, MI, USA.

¹⁰ Professor Emeritus, Department of Kinesiology and Health Education, University of Texas at Austin, and Research Professor, Tarleton State University, Stephenville, Texas

Dr Sean P. Cumming

1W 4.110

Department for Health

University of Bath

Bath, BA2 7AY

s.cumming@bath.ac.uk

Acknowledgement

The authors would like to thank Ged Roddy MBE, Director of Football Development for the FA Premier League, and Dean Smith, Games Programme Manager at the FA Premier League, for their support in initiating and implementing the bio-banded tournament. We would also like to express our gratitude to the coaches, practitioners and players at Norwich City, Southampton, Stoke City, and Reading for their involvement in and contributions towards the study.

Key Words: Maturation, Football, Youth, Adolescence, Bio-banding,

Abstract

Individual differences in the growth and maturation have been shown to impact player performance and development in the context of youth soccer. This study investigated Premier League academy players' experiences of participating in a tournament bio-banded for biological maturation. Academy players (N=66) from four professional soccer clubs between 11 and 14 years of age and between 85-90% of adult stature participated in a tournament. Players competed in three 11 vs 11 games on a full size pitch with 25-minute halves. Sixteen players participated in four 15-minute focus groups and were asked to describe their experiences of participating in the bio-banded tournament in comparison to age group competition. Age groups in the UK are based upon where a player's birth date falls in relation to the cut of dates for the school year (September 1st to August 31st). All players described their experience as positive and recommended the Premier League integrate bio-banding into the existing games programme. In comparison to age-group competitions, early maturing players described the bio-banded games more physically challenging, and found that they had to adapt their style of play placing a greater emphasis on technique and tactics. Late maturing players considered the games to be less physically challenging, yet appreciated the having more opportunity to use, develop and demonstrate their technical, physical, and psychological competencies. Bio-banding strategies appear to contribute positively towards the holistic development of young soccer players.

INTRODUCTION

Bio-banding is the process of grouping of athletes on the basis of attributes associated with growth or maturation, rather than chronological age (Cumming, Lloyd, Oliver, Eisenmann & Malina, 2017). Proponents of bio-banding contend that restricting maturity-associated variance in size, strength and skill results in greater competitive equity and, potentially, a reduced risk of injury (Baxter-Jones, 1995; Gallagher, 1969; Malina & Beunen, 1996; Seefeldt, 1981). It has relevance to numerous aspects of athlete development, including talent identification and development, strength and conditioning, and competition. Bio-banding does not preclude the consideration of individual differences in technical and psychological development.

Examples of bio-banding can be observed in a number of sports. Junior athletes in many combat sports (e.g., wrestling, boxing, judo, taekwondo) are grouped by age and weight, mirroring the competitive weight divisions that exist at the adult level (Albuquerque et al., 2015; Albuquerque et al., 2012; Delorme, 2014). In collision sports (e.g., rugby, American football) where greater size and physical aptitude has implications for performance and safety, some organizations (e.g. Auckland Rugby Union, Pop Warner Football) have grouped athletes by age and weight, though this is the exception rather than the norm (World Rugby, 2016). Weight based criteria have also applied to specific positions in American football, such as ball carriers (i.e., running backs, quarterbacks, wide receivers).

Body size has limited impact on player performance and selection in youth soccer, excluding the positions of goalkeeper, centre back, and, increasingly, centre-forward positions where above average height is desirable (Malina, 2003; Vaeyens et al., 2006). Thus, grouping soccer players by size has limited practical value or empirical basis. Biological maturation is, however, a well-documented predictor of player fitness, performance, and

selection in youth soccer (See Meylan, Cronin, Oliver, & Hughes, 2010). Maturation refers to progress towards the adult stature and can be considered in terms of stage, tempo (i.e., rate of maturation), and timing. It should not be confused with relative age which represents chronological age relative to the individual birth record and competition cut off dates, and is, at most, a weak-to-moderate proxy of maturation, especially in samples of elite junior athletes (Johnson, Farooq, & Whiteley, 2017; Malina, Ribeiro, Aroso, & Cumming, 2007). A selection gradient towards early maturing males is evident from 12-13 years and increases with age and competitive level (Coelho e Silva et al., 2010; Figueiredo, Goncalves, Silva, & Malina, 2009; Johnson et al., 2017; Malina, 2011). Players advanced in biological maturation perform better in tests of strength and power, and, to a lesser extent, skills (Figueiredo, et al., 2009; Malina, Eisenmann, Cumming, Ribeiro, & Aroso, 2004; Malina, Ribeiro, et al., 2007; Meylan, et al., 2010). During games, early maturing boys also cover greater distances at high speed, reach higher peak speeds, and are involved in a greater frequency of high-intensity and repeated high-intensity actions (Buchheit & Mendez-Villanueva, 2014).

Maturity-associated differences in size and function present challenges for those tasked with identifying and developing young soccer players. This is especially true when players compete within chronological age groups, where variation in maturation is marked (Figueiredo, Silva, Cumming, & Malina, 2010). Age groups in the UK are based upon where a player's birth date falls in relation to the cut off dates for the school year (September 1st to August 31st). While chronological age groups may afford an ideal context in which to match players on the basis of cognitive, motor, and social development and playing experience, they do not account for individual differences in physical maturation. Players who are advanced in maturation are more likely to be successful and are, thus, perceived by coaches and scouts as more talented (Malina, 2003). As a consequence, early maturing boys are more likely to be recruited into, and retained within, the Academy systems, resulting in greater access to

specialist coaching, training resources, and investment in their development (Bloom & Sosniak, 1985; Malina, Rogol, Cumming, Silva, & Figueiredo, 2015). They are also more exposed to higher standards of competition and challenge, through their involvement in more elite level programmes. Conversely, late maturing boys are more likely to be overlooked, excluded, or denied developmental opportunities, regardless of ability (Cobley, 2016). A recent study of English and Qatari Academy soccer players found that those advanced in maturation were up to 20 times more likely to be retained within the academy system, with selection biases most evident in the oldest age groups (Johnson, et al., 2017). Similarly, a recent longitudinal study of elite junior Swiss soccer players aged 12 to 15 years found that late maturing boys, though more skilled and motivated, consistently failed to progress to the highest performance levels (Zuber, Zibung, & Conzelmann, 2016). This is a particular concern given that the emergence of talent can take several years and may not be detectable until late adolescence or early adulthood (Simonton, 1999).

The athletic advantages associated with early maturation present an interesting paradox in the context of youth soccer. Whereas advanced maturity affords an initial advantage in performance and selection, it may be disadvantageous in the long term. The competitive and selective nature of Academy soccer encourages early maturing boys to play to their strengths (i.e., size, strength and power), at the neglect of their technical and tactical development (Malina, et al., 2015). Adolescence represents a period of heightened neural refinement and specialisation, whereby frequently and rarely used neural connections are strengthened or removed, respectively (Blakemore, Burnett, & Dahl, 2010). A failure to use and/or develop one's technical and tactical skills during childhood and adolescence could have important implications for both learning and skill development (Johnson, Blum, & Giedd, 2009). This may explain why those soccer players identified as the most talented at the youth level often fail to meet coaches' expectations in late adolescence/young adulthood,

when maturity-associated differences in size and function are attenuated and/or reversed (Brewer, Balsom, & Davis, 1995; Lefevre, Beunen, Steens, Claessens, & Renson, 1990; Malina et al., 2015). As noted, anthropometric and physical attributes observed in youth are considered to be poor predictors of success at the adult level (Till et al., 2010).

To accommodate individual differences in biological maturation and optimise talent identification and development, practitioners might consider periodically grouping players for competition by maturation status, rather than age (i.e. bio-banding; Baxter-Jones, 1995; Malina & Beunen, 1996). Through the diversification of challenge and the learning environment, the process of bio-banding can theoretically benefit both early and late maturing players. Competing against older and more physically matched peers, early maturing boys would no longer be able to rely on their physical advantages and would be encouraged to use and develop their technical and tactical attributes. It would also prepare them for the future challenges where they will have to compete against equally, if not, more mature players (i.e. in both open age and adult competitions). A more physically balanced competitive environment could also afford the late maturing player greater opportunity to both use and demonstrate the physical and technical attributes. Limiting maturity associated differences in both size and function might also benefit Academy managers, coaches, and scouts, allowing them to evaluate players in a different developmental context and look beyond individual differences in physical maturity.

In consideration of the potential benefits of bio-banding for player development, the purpose of this study was to examine experiences and perceptions of youth soccer players participating in a competitive tournament in which players were grouped by maturation rather than chronological age. Four professional soccer clubs (Southampton, Stoke City, Reading, & Norwich City) participated in a bio-banded tournament organized by the Premier League. Each club created a squad of players, each of whom fell within an agreed maturation band

(85-90% of Predicted Adult Stature). Clubs were encouraged to consider each player's psychological and technical/tactical development and were permitted to exclude players of the desired maturity status who might not benefit from the bio-banded format. For example, a club might choose not to include an early maturing boy who lacked technical and/or psychological maturity to 'play up' a level, or a late maturing boy who was already thriving within their age group. Such judgements were based upon the collective knowledge and experiences acquired by the practitioners (i.e., coaches, sports psychologists, and scientists) through their interactions with the players. Although such judgments are subjective in nature they are ecologically valid in that they are consistent with the processes used for determining athletic readiness (to play up or down an age group) in academy soccer. Select groups of younger, earlier maturing (those playing up) and older, later-maturing boys (those playing down) were invited to participate in a series of focus groups in which they were asked to describe their experiences participating in the bio-banded games.

METHOD

Participants

Academy soccer players (N=66) from four professional soccer clubs aged 11-14 years and between 85-90% of predicted adult stature at the time of measurement participated in a bio-banded tournament organized by the Premier League. Squad sizes ranged from 16 to 17 players. Collectively, these players were drawn from the under 12 to the under 15 years competitive age groups. The number of players from each age group was as follows; under 12's (n=6), under 13's (n=35), under 14's (n=19), under 15's (n=6). A select group of participants (n=16), four identified by each club, were invited to participate in a series of four semi-structured focus groups. All participants in the focus group spoke English as first language. The groups included eight players identified as advanced in maturation for their age (Maturity Z score $>.2$), and eight identified as being delayed in maturity for their age

(Maturity Z score < -0.2), based on information provided by the clubs prior to the tournament. The maturity z scores were calculated on the basis of the participant's percentage of predicted adult stature and age and sex specific reference values (Bayer & Bailey, 1959). A more detailed explanation of this process can be found in the validation paper published by Malina and colleagues (Malina, Dompier, Powell, Barron, & Moore, 2007). Mean values for age and maturity status for the early and late maturing groups were as follows (Early: \underline{M} age = 12.4 years (SD=0.6), \underline{M} Maturity Z Score = 0.72 (SD=0.4); Late: \underline{M} age = 13.6 years (SD=0.7), \underline{M} Maturity Z Score = $-.57$ (SD=0.21)).

Procedure

Prior to commencing the study, institutional ethical approval was granted by the host institution's research ethics board and all relevant parties (players/parent/guardian/club) were fully informed about the nature of the research. Passive consent was obtained from the parent/guardian(s) of the children participating in the study with each academy head acting in loco parentis.

The Khamis-Roche method (Khamis & Roche, 1994) was used to predict mature height from current age, height and weight of the participant and mid-parent height (average height of biological parents). Between the ages of 4 and 18 years, the median error bound between actual and predicted mature height is 2.2 cm in males (Khamis & Roche, 1994). Biological parent height was self-reported and adjusted for over-estimation using equations based upon measured and self-reported heights of US adults (Epstein, Valoski, Kalarchian, & McCurley, 1995). The Khamis-Roche method has been used with US and British youth (Cumming, Battista, Standage, Ewing, & Malina, 2006; Malina, Morano, Barron, Miller, & Cumming, 2005; Malina et al., 2006; Sweet, Dompier, Stoneberg, & Ragan, 2002) and validated against established indicators of maturity (i.e. skeletal age) in junior American football players (Malina, Dompier, et al., 2007) and Portuguese soccer players (Malina, Silva,

Figueiredo, Carling, & Beunen, 2012) A criterion of 85-90% of adult stature was used to 'bio-band' players into their respective squads. This band was selected on the basis that it represented a developmental phase that included late childhood and the initiation of the pubertal growth spurt. Trained academy staff assessed heights and weights within two weeks of the competition, using standardised field practices. Staff were trained in advance of the competition as part of a league-wide initiative by a level 4 ISAK anthropometrist.

The bio-banded tournament involved each club playing one another across three 11 vs. 11 games with 25-minute halves. Games were played on a standard pitch (field) with a size 5 ball, and conformed to standard officiating and rule procedures. Player substitutions followed standard Football Association rules (3 per game) and were permitted throughout the games.

The focus groups employed both written and spoken methods, and were conducted between the second and third matches. Prior to the focus groups, each participant was asked to provide verbal assent. At the start of each focus group, the participants were instructed to write-down, on a set of notepads, any positive and/or negative experiences associated with participating part in the bio-banded tournament in comparison to age group competitions. Participants were given five minutes to complete this task. The written task was designed to stimulate thought, provide the participants with sufficient time and opportunity to recall and reflect upon their experiences, identify shared experiences, and to aid group discussion (Keats, 2009). This technique also permits the participants to use their own words, and not those of the researcher, when talking about their experiences. This helps create data and understanding that is grounded within the participants' own social realities (Wills, 2012). Using these notes as a prompts, the participants were then asked to describe and discuss their experiences competing in the bio-banded tournament. The four focus groups ranged in duration from 12 to 17 minutes and the audio recordings were transcribed verbatim. To

ensure anonymity, participants' names were removed from the interview transcripts and renamed P1-8 (early maturing) and P9-16 (late maturing).

Data Analysis

Given the novel and exploratory nature of this research an inductive reasoning approach was adopted for the analysis of the data. Inductive reasoning is based upon learning and from experience and is considered a bottom-up approach to knowing (Sparkes & Smith, 2013). That is, knowledge, meaning and theory are derived through the observation of patterns and relationships present within the data, rather than the testing of pre-established theory and/or hypotheses. While this approach does not prevent the researcher from considering existing theory and research, researchers adopting inductive methods do not establish hypotheses in the initial phases of the research process. Inductive reasoning is considered to be a more appropriate method when asking research questions that are novel, open-ended and/or exploratory in nature (Angrosino, 2007).

Transcripts were analysed using established guidelines for inductive thematic content analysis (Braun & Clarke, 2006). This approach aims to identify, analyse and report patterns (themes) within the data, and to enable interpretation of the themes in relation to the research question(s). Thematic analysis inherently entails both judgement and interpretation on the part of the researcher. It was, therefore, necessary to maintain an awareness of researcher bias throughout the process. To ensure accuracy and reliability of the themes generated, derivation of themes was triangulated among three members of the research team (SC, SM, DB) (Sparkes & Smith, 2013).

RESULTS

Four themes emerged as central to player experiences and perceptions of the bio-banded tournament. (1) *Physical development* reflected the beliefs of players regarding physical differences, benefits and challenges presented by the bio-banded competitions; (2)

Technical and Tactical Development considered player experiences in relation to adapting their technical and tactical aspects of play, technical and tactical challenges encountered, benefits of playing with and against players of mixed age and experience, and opportunities to demonstrate technical competence; (3) *Psychosocial Development* represented player perceptions regarding psychological aspects of the learning experience and the opportunity to develop positive psychological and behavioural traits; and (4) *Overall experience* reflected players' evaluations of the bio-banded strategy and opinions as to whether or not the Premier League should continue to invest in such tournaments. Each theme is discussed subsequently; selected quotations of participants are presented in Tables 1-3.

Physical Development (Table 1)

"It gives us more freedom...we get a chance to prove to ourselves that when we are up against people our same size, we're good. We're really good... and make an impact on the game". - P1, Late Maturing Male.

Early and late maturing players agreed that bio banding created a physically more equitable playing field, reducing differences in player size and function (P1, P6, P9, P10). The early and late maturing players also reported that the practice of bio-banding encouraged a style of play that was less physical and more technically and tactically oriented (P1-2, P5-7, P11-13). Players advanced in maturation found the games to be more physically challenging than age group competitions (P9-11), limiting the extent to which they could use their physical attributes to succeed and control the game (P9). This was, however, considered beneficial in that it encouraged them to use and develop their technical and tactical skills (P14). It also prepared them for future competition against 'bigger and better teams' (P9-10).

Two early maturing players perceived a greater risk of injury from playing up, though no injuries were reported (P12-13).

As expected, late maturing players described the bio-banded competition as less physical challenging than age group competitions. While late maturing boys still valued the challenge of competing against physically more able and mature peers, (P1, P2) it was equally evident that they appreciated the benefits of competing in bio-banded games (P1, P5, P6). More specifically, late maturing players reported having greater opportunity to use and develop their technical, tactical and physical competencies, and demonstrate their true potential (P1). Late maturing players also reported being more able to utilise and develop skills that required a greater element of physicality (i.e., shielding the ball, making challenges) (P5).

Technical and Tactical development (Table 2)

“You’ve got to use your technical ability more than your physical ability. Well, it was a faster tempo with the older lads. And yeah, they’re a lot more physical than the younger ones.it made it challenging”. - P12 Early Maturing Male

As noted previously, early and late maturing players agreed that bio-banding encouraged a more technically and tactically oriented style of play (P2, P7, P11-13). Late maturing players reported greater freedom and opportunity to use and demonstrate their technical and tactical skills to impact and/or control games, and in turn to experience success (P1-P2). They also believed that such competitions afforded more opportunity for coaches to evaluate their potential in a more developmentally appropriate context (P2). Late maturing players reported that they adapted their style of play in order to accommodate their younger and/less experienced peers (i.e. teamwork) (P1, P4). This required adopting positions of

leadership, creative problem solving, and a greater emphasis upon communication, especially during set pieces (e.g. corners) (P1, P4).

Early maturing boys perceived the process of competing against ‘older’ and more physically matched players as a superior challenge and a better test of their ‘touch and ability’ (P9, P11-12). The early maturing boys also reported that in the absence of a physical advantage they had to adapt their game, placing greater emphasis upon both technique and tactics (P13). More specifically, they reported having to read the game differently, employing new tactics to beat opponents, and having to release the ball and make game-related decisions more quickly (P9, P11).

Psychosocial Development (Table 3)

“It made me more confident, playing with older boys, and getting used to the pace. Made me quicker on the ball and stuff”. - P12 Early Maturing Male

Several psychosocial benefits and limitations associated with bio-banding were noted. Whereas some late maturing players reported greater confidence from participating in the tournament (P7) and more composure on the ball, (P2) others perceived higher expectations to succeed (i.e. outperform younger players) and assume positions of responsibility (i.e. leadership roles).(P1-3) Consistent with the latter observation, both early and late maturing players described the older yet late maturing boys as being more likely to assume positions of leadership, organising, mentoring and supporting their younger peers.(P1, P3, P5, P7, P13, P15)

Through participation in the bio-banded tournament, early maturing boys reported feeling more ‘confident’ in their technical skills and their ability to compete against older and more physically matched opponents.(P12, P15) They also described feelings of ‘pride’ and of

having gained more 'experience' from playing against older and more physically capable and skilful players (P7, P10, P16). From a learning perspective, the early maturing players reported benefitting from the guidance and support provided by their older peers, particularly following mistakes (P13, P15).

Overall experience

All 16 focus group participants described the tournament as a positive and welcome addition to their games programme (P1-16) and recommended that the Premier League continue with this initiative. The early maturing players were particularly positive about their experiences stating that bio-banding offered a superior challenge and helped prepare them for future competition against older and/or equally mature players. "You learn a lot more playing like this than you would normally playing with your age group." (P13). "Keep going with this tournament, because it's really good for our experience, for when we get older, and (compete against) bigger, and stronger teams." (P11).

The later maturing players reasons for supporting the bio-banding initiative were founded upon an awareness that later maturation and/or smaller size presented a temporary disadvantage in soccer, and that such bio-banding afforded more opportunity to demonstrate and apply their technical, tactical, and physical attributes. Further, the late maturing males believed that this would result in more positive evaluations from coaches and a greater likelihood of being retained within the academy system. "I feel like it's given us more chance to stay at the club. Finally, people have been realising that small players are good for the academies. There's been a lot of players in all academies that have been dropped because they're too small."(P2).

DISCUSSION

This study is the first to have explored athletes' experiences of competing in a tournament in which they were grouped by maturation rather than chronological age. Early and late maturing players' agreed that the process of matching players by maturational status, rather than age, helped attenuate maturity associated differences in size and function and resulting in greater competitive equity. Similarly, both early and late maturing players described the bio-banded games as a positive and welcome addition to their games program; unanimously recommending that the Premier League continue with this initiative. Early and late maturing players did differ, however, in how they perceived bio-banding as benefitting their own development.

Players advanced in maturation consistently described the bio-banded games as a superior physical challenge and learning stimulus (in comparison to age group competition), and as an essential step in preparing them for future competitions against adult and/or more physically able opponents. Specifically, the bio-banding strategy encouraged them to adapt their game, emphasising technique, tactics, and teamwork over physicality. It also challenged them psychologically, forcing them to process information in new ways, making decisions and releasing the ball more quickly. Effectively, bio-banding provided the early maturers with a more diverse set of learning experiences, exposing them to many of the developmental challenges traditionally encountered by those delayed in maturity. The inclusion of structured challenge and the development of psychological skills have long been recognised as essential features in the development of talented young athletes (Gould, Dieffenbach, & Moffett, 2002; Savage, Collins, & Cruickshank, 2016; Toering, Elferink-Gemser, Jordet, & Visscher, 2009). Quality preparation has also been noted as a priority factor in facilitating effective athlete progression and successful transitions to the elite adult level within the talent development environment (Finn & McKenna, 2010; Martindale & Nash, 2013).

As expected, late maturing players described the bio-banded games as less physical challenging than age group competition. That said, they also identified a number of advantages associated with the bio-banding strategy including a greater opportunity to (i) utilise, demonstrate and develop certain technical, physical and psychological attributes, (ii) exert their influence on the game, and (iii) adopt positions of leadership and (iv) mentor younger athletes. Late maturing boys also reported greater confidence and composure on the ball. Confidence has been shown to be a key predictor of success and development in sport (Hays, Thomas, Maynard, & Bawden, 2009). Whereas late maturing players reported greater composure on the ball as a result of being more physically matched, they also reported greater pressure and expectations to succeed when competing against their younger peers. As such, it would appear that the process of bio-banding may differentially influence the stress response dependent upon which aspects of performance is being considered. In agreement with early maturing players, those delayed in maturation described the bio-banded games as encouraging a more technically and tactically oriented and less physical style of play, with a greater reliance on both teamwork and communication.

Several challenges unique to bio-banding were identified by the players, including age related differences in psychological and social development, game knowledge and experience, differences in equipment and pitch size, and playing with new teammates. Age related differences in psychosocial development have been highlighted as potential arguments against bio-banding (Tucker, Raftery, & Verhagen, 2016). That said, in the current study players generally perceived these challenges as learning opportunities; encouraging them to, (i) learn new skills, (ii) better realise their strengths and weaknesses, (iii) engage in creative problem solving, (iv) adopt new roles and responsibilities, and (v) play with and make new friends. As noted previously, exposure to novel structured challenges is considered an

essential ingredient in the development of the physical and psychological attributes necessary excellence (Martindale & Nash, 2013).

Although players understood and appreciated the benefits of participating in bio-banded competitions, it is evident that they still valued and wanted to continue competing within their respective chronological age groups. Late maturing players, in particular, recognised the benefits of having to compete against players who are physically larger and/or more mature. Accordingly, a more effective and efficient player development programme should include the provision of both bio-banded and age group competitions. That is, bio-banded should serve as an adjunct to age group competition, and not as a replacement. Collectively, these formats would provide a more diverse, multifaceted, and developmentally appropriate development games programme. Opt-in bio-banded competitions could, for example, be offered on a monthly or bi-monthly basis as part of the existing game programme. Such a 'hybrid approach', as recommended by Tucker and colleagues, would retain the benefits of age group competition whilst simultaneously addressing its limitations. It would also expose players to a broader and more diverse range of learning contexts, optimising player development, skill acquisition and welfare (Tucker, et al., 2016). The introduction of structured and diverse challenges is considered to be an essential feature in the development of talented young athletes. Bio-banding, as a practice, could be employed as one element of a holistic approach to athlete development, affording late and early maturing more opportunities to experience the challenges and develop the characteristics necessary for success at the elite senior level (Martindale, Collins, & Abraham, 2007). A hybrid approach would also permit coaches and scouts to assess players' abilities and potential across a broader range of learning environments. It could also enhance the talent identification process, through a reduction in errors of inclusion (i.e., selection of less talented early maturing boys) and exclusion (i.e., de-selection of talented late maturing boys).

It can be argued that, for the late developer, bio-banding reduces the challenge necessary for the development of athletic excellence. This argument only holds, however, if the challenge faced by the late developers is surmountable and if they no longer compete in age group competitions. As noted, late maturing boys, regardless of technical and psychological ability, are markedly less likely to be retained and/or progress within the academy system (Johnson, et al., 2017; Zuber, et al., 2016). This suggests that the challenge of competing against their physically more mature peers is, for the majority late developers, simply too much. As bio-banding is being used as an adjunct to age group competition, late developers are also still exposed to these more formidable challenges within their games programme. This argument against bio-banding also fails to recognise that early maturing boys experience insufficient challenge in age group-competition and that bio-banding, as an adjunct, provides a more optimal learning environment.

To support bio-banding initiatives it is important that the academies educate coaches, scouts, practitioners, players and parents on the subject of growth and maturation (Cumming et al., 2017). Learning objectives should include understanding the processes of growth and maturation, how it is assessed, and the impact of puberty and timing of puberty upon physical, psychological and athletic development (Malina et al., 2015). Such educational initiatives should also explain the purpose and methods of bio-banding, explaining how early and late maturing athletes may benefit from competing against youth who are older or younger, respectively, yet of a similar physical maturity. Further topics of consideration might include the relative age effect, the role of maturation in relation to the design and implementation of strength and conditioning programmes, growth related injuries, and adolescent changes in circadian rhythms and sleep behaviour.

Limitations of the study should be noted. The findings are limited to the experiences of 16 players from four clubs; players were 11-14 years of age and attained 85% to 90 % of

predicted adult height. The results of this study thus may not generalise to players competing for different clubs, of different ages, and/or of varying maturity status. Likewise, the findings may not generalize to female players, players in different leagues or countries, and or athletes competing in different sports. It should also be noted that the criteria for identifying players as advanced and delayed in maturation were less conservative than have been applied in previous research (e.g., Z score >1 , or <-1) (Malina, et al., 2005), however the application of a more stringent set of criteria was not possible in such a comparatively small sample of players. It is equally important to recognize that this is the first study to examine player experiences of bio-banding and further research is required to understand the benefits and limitations of such strategies. Subsequent studies might also consider the development and/or use of psychometric instruments to capture the benefits and or limitations of bio-banding, focussing upon constructs such as enjoyment, effort, competitiveness, leadership, resilience, creativity, and motivation. The practice of bio-banding should also be considered in relation to how it may foster the physical and psychological skills that facilitate the pathway to the elite level. Future studies might wish to examine the benefits of bio-banding with players of different ages, different maturity bands, and perhaps athletes in different sports. Further, such studies might also seek to examine the impact of bio-banding upon in game performance, using technologies such as match analysis or GPS, other potential important outcomes such as enjoyment, confidence, stress, and/or perceived risk of injury via psychometric instruments.

In summary, the players interviewed perceived the experiences of competing in a bio-banded tournament as positive and contributing towards their physical, psychological, and social development. As a developmental strategy, bio-banding was considered to present a unique set of challenges that contributed towards the holistic development of the athlete and afforded a more diverse and developmentally sensitive learning environment. All of the

players interviewed also recommended that the Premier League continue with this strategy and integrate it within the existing academy games programme. Accordingly, those involved in the identification and development of talented young athletes should consider and further investigate the potential benefits of bio-banding practices in sport.

Table 1. Physical development

Sub theme	Qualitative evidence
Greater competitive equity	<i>It was more beneficial, and it's more competitive. More equal. More of a physical challenge. (P9;EM)</i>
	<i>I felt the same, not just physically, which can good, but sometimes it's harder, and expect a bit of a challenge... It can be a positive, because ... it gets you ready for when you're older, playing bigger and better teams. you have to get used to it, when you're playing older people. (P10;EM)</i>
	<i>... it gives us more freedom and, like I said before, a sense of-- we get a chance to prove to ourselves that when we are up against people our same size, we're good. We're really good. And make an impact on the game. (P1;LM)</i>
Less physical challenge	<i>I find it a bit easier playing with youngers and that (was a) negative, because that's not as much of a challenge. (P1;LM)</i>
	<i>So I quite like it to be quite physical, because it makes me play better, because I maybe can move the ball a bit quicker than normally (P2;LM)</i>
	<i>...85% of the time, we're going up against players bigger than us and you can't always just beat your man physically.....when the ball comes into you, say you've got someone on your back, you can hold off a bit more easier So instead of just the big guys can get their legs around you and push you off it, but then with smaller ones, they have to try and get around you. It's a bit easier to hold them off (P1;LM)</i>
	<i>It's nice for me to be able to physically beat my opponent (P1;LM)</i>
Use of physicality	<i>... I could use my physical strengths. Sometimes I do at my age group, but I've done it more today. (P5;LM).</i>

	<i>I don't use my strength as an advantage, as much as I do with my own age group. (P9;EM)</i>
	<i>When a younger one plays on a big pitch, like that, it makes it hard for us, the older ones, because (P4;LM) we've got to recover quicker (P1;LM). Yeah. I felt like I've done a lot of running today. (P4)</i>
Injury risk	<i>When you went into tackles, the older lads go in stronger, because they're obviously stronger than you. So that sometimes gets you hurt more. (P12;EM)</i>

Table 2. Technical and Tactical Development

Sub theme	Qualitative evidence
Opportunity to use, develop, & demonstrate technique	<i>In a normal game, I might only be able to do a bit of magic twice maybe, but in here, every time you get the ball there's a chance that you can do it easier." (P1;LM)</i>
	<i>You've got to use your technical ability more than your physical ability. Well, it was a faster tempo with the older lads. And yeah, they're a lot more physical than the younger ones.it made it challenging (P12;EM)</i>
	<i>With the older ones, you had to use more of your technical side of the football, not the physical, because they're going to be stronger than you. So it will be harder. (P11;EM)</i>
	<i>I had a better experience playing with the older boys, because they helped me within the game if I was struggling to do other things. And it was more beneficial for us. (What kind of aspects? – Interviewer) My technique (P11;EM)</i>
Challenge and adaptation	<i>It's definitely made me lose (pass) the ball quicker than I normally would. (P9;EM)</i>
	<i>Rather than using your physical and athletic strengths and attributes, sometimes you have to use your technical side more than your physical. So if the other team's quicker and stronger than you-- so let's say you're playing that two years or one year and that's quicker and stronger than you, you'd have to maybe sometimes play one and two touch than play it round them rather than trying to hold it up and have them out-strength you and get on the counter. (P14, EM)</i>
	<i>I've got play with different players. So more experience... I change my game a bit to suit the other players. Being the older player you have to adapt your game (P4;LM)</i>

Teamwork and communication	<i>I had a better experience playing with the older boys, because they helped me within the game, if I was struggling to do other things. And it was more beneficial for us. My technique, I don't know how to explain it, really, but my technique... shooting and cross. (P11;EM)</i>
	<i>I think we communicate more today because we have to.... whereas our own age group, they already know..... Like set plays, like corners and stuff (P4, LM)</i>
	<i>We had a few older boys and a few youngsters but there's not really been any miscommunication anywhere. They've gelled in pretty nicely. (P14, EM)</i>

Table 3. Psychosocial development

Sub theme	Qualitative evidence
Pressure	<i>You're also more composed on the ball— Because there's not a massive 6' 5" player running up-- So you know that it's somebody your size, you can push off as well as keep the ball. (P2;LM)</i>
	<i>They (younger players) put you under pressure more often. Because they think because you're the older one, he can do everything. (P1;LM)</i>
	<i>It puts you under pressure as well, because the coaches also think, because we're the old ones, that we have to be amazing because we're the old ones (P2;LM)</i>
Psychological growth	<i>It made me more confident, playing with older boys, and getting used to the pace. Made me quicker on the ball and stuff. (P12;EM)</i>
	<i>I feel more confident playing up, so learn more things, because we've got [an] under 14's coach, which I haven't really been with him before and other players that I haven't really been with. (P15;EM)</i>
	<i>I thought it was good that you get the chance to play teams that you don't always play. And it sometimes makes you feel more experienced, that you're playing different teams, not always the same. (P10;EM)</i>
	<i>When you do actually go back to your own age group, you do feel more confident. (P7;LM)</i>
	<i>Because you usually just play the teams that are local. But then to play older and different teams, it made me feel a bit prouder, and stuff like that. (P10;EM)</i>
Leadership and mentoring	<i>It's nice to play with the younger ones as well....and be the older one in the group....and maybe the more physical one in the group as well. Because we'll be playing with the younger ones, so, it's nice to be like the leader as well. You can control it (the game)” (P2;LM) “I mean, it doesn't stop you from being a leader in your own age group-- But it's easier to take control (P1;LM)</i>
	<i>They always look to you for leadership, and that puts pressure on your shoulders...we do stuff, we have to tell all them, and they have to learn it through the games. To the last game, hopefully they'll understand. (P4;LM)</i>
	<i>The other teammates try to encourage you, like if you've does something wrong or need to improve. But they will say positive stuff. (P15;EM) The older ones drive you on. (P13;EM)</i>

--	--

REFERENCES

- Albuquerque, M. R., Franchini, E., Lage, G. M., Da Costa, V. T., Costa, I. T., & Malloy-Diniz, L. F. (2015). The relative age effect in combat sports: An analysis of Olympic judo athletes, 1964-2012. *Perceptual and Motor Skills*, 121(1), 300-308. doi: 10.2466/10.Pms.121c15x2
- Albuquerque, M. R., Lage, G. M., da Costa, V. T., Ferreira, R. M., Penna, E. M., Moraes, L. C. C. D., et al. (2012). Relative age effect in Olympic taekwondo athletes. *Perceptual and Motor Skills*, 114(2), 461-468. doi: 10.2466/05.25.Pms.114.2.461-468
- Angrosino, M. (2007). *Doing ethnographic observational research*. London: Sage.
- Baxter-Jones, A. D. G. (1995). Growth and development of young athletes: Should competition levels be age related. *Sports Medicine*, 20(2), 59-64.
- Bayer, L. M., & Bailey, N. (1959). *Growth diagnosis: Selected methods for interpreting and predicting development from one year*. Chicao, Il. : Chicago University Press.
- Blakemore, S. J., Burnett, S., & Dahl, R. E. (2010). The role of puberty in the developing adolescent brain. *Human Brain Mapping*, 31(6), 926-933. doi: 10.1002/hbm.21052
- Bloom, B. S., & Sosniak, L. A. (1985). *Developing talent in young people*. New York: Ballantine Books.
- Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77-101. doi: 10.1191/1478088706qp063oa
- Brewer, J. H., Balsom, P., & Davis, J. (1995). Season birth distribution amongst European soccer players. *Sports, Exercise and Injury*, 1, 154-157.
- Buchheit, M., & Mendez-Villanueva, A. (2014). Effects of age, maturity and body dimensions on match running performance in highly trained under-15 soccer players. *Journal of Sports Sciences*, 32(13), 1271-1278. doi: 10.1080/02640414.2014.884721

- Cobley, S. (2016). Talent identification and development in youth sports. In K. Green & A. Smith (Eds.), *Routledge handbook of youth sport* (pp. 476-491). Abingdon: Routledge.
- Coelho e Silva, M. J., Figueiredo, A. J., Simoes, F., Seabra, A., Natal, A., Vaeyens, R., et al. (2010). Discrimination of u-14 soccer players by level and position. *International Journal of Sports Medicine*, 31, 790-796.
- Cumming, S. P., Battista, R. A., Standage, M., Ewing, M. E., & Malina, R. M. (2006). Estimated maturity status and perceptions of adult autonomy support in youth soccer players. *Journal of Sports Sciences*, 24(10), 1039-1046. doi: 10.1080/02640410500386142
- Cumming, S. P., Lloyd, R. S., Oliver, J. L., Eisenmann, J. C., & Malina, R. M. (2017). Bio-banding in sport: Applications to competition, talent identification, and strength and conditioning of youth athletes. *Strength & Conditioning Journal*, 39(2), 34-47.
- Delorme, N. (2014). Do weight categories prevent athletes from relative age effect? *Journal of Sports Sciences*, 32(1), 16-21. doi: 10.1080/02640414.2013.809470
- Epstein, L., Valoski, A. M., Kalarchian, M. A., & McCurley, J. (1995). Do children lose and maintain weight easier than adults? A comparison of child and parent weight changes from six months to ten years. *Obesity Research*, 3, 411-417.
- Figueiredo, A. J., Goncalves, C. E., Silva, M. J. C. E., & Malina, R. M. (2009). Characteristics of youth soccer players who drop out, persist or move up. *Journal of Sports Sciences*, 27(9), 883-891. doi: 10.1080/02640410902946469
- Figueiredo, A. J., Silva, M. J. C. E., Cumming, S. P., & Malina, R. M. (2010). Size and maturity mismatch in youth soccer players 11-to 14-Years-Old. *Pediatric Exercise Science*, 22(4), 596-612.

- Finn, J., & McKenna, J. (2010). Coping with academy-to-first-team transitions in elite English male team sports: The coaches' perspective. *International Journal of Sports Science & Coaching*, 5(2), 257-279.
- Gallagher, J. R. (1969). Problems in matching competitors - Adolescence, athletics and competitive sports. *Clinical Pediatrics*, 8(8), 434-&.
- Gould, D., Dieffenbach, K., & Moffett, A. (2002). Psychological characteristics and their development in Olympic champions. *Journal of Applied Sport Psychology*, 14(3), 172-204. doi: 10.1080/10413200290103482
- Hays, K., Thomas, O., Maynard, I., & Bawden, M. (2009). The role of confidence in world-class sport performance. *Journal of Sports Sciences*, 27(11), 1185-1199. doi: 10.1080/02640410903089798
- Johnson, A., Farooq, A., & Whiteley, R. (2017). Skeletal maturation status is more strongly associated with academy selection than birth quarter. . *Science and Medicine in Football*, 1-7.
- Johnson, S. B., Blum, R. W., & Giedd, J. N. (2009). Adolescent maturity and the brain: The promise and pitfalls of neuroscience research in adolescent health policy. *Journal of Adolescent Health*, 45(3), 216-221. doi: 10.1016/j.jadohealth.2009.05.016
- Keats, P. A. (2009). Multiple text analysis in narrative research: visual, written, and spoken stories of experience. *Qualitative Research*, 9(2), 181-195. doi: 10.1177/1468794108099320
- Khamis, H. J., & Roche, A. F. (1994). Predicting adult height without using skeletal age: The Khamis-Roche method. *Pediatrics*, 94, 504-507 (Pediatrics, 595, 457, 1995 for the corrected version of the tables).

- Lefevre, J., Beunen, G., Steens, G., Claessens, A., & Renson, R. (1990). Motor-performance during adolescence and age 30 as related to age at peak height velocity. *Annals of Human Biology*, 17(5), 423-435. doi: Doi 10.1080/03014469000001202
- Malina, R. M. (2003). Growth and maturity of young soccer (football) players. In T. Reilly & A. M. Williams (Eds.), *Science and soccer* (pp. 287-306). London: Routledge.
- Malina, R. M. (2011). Skeletal age and age verification in youth sport. *Sports Medicine*, 41(11), 925-947.
- Malina, R. M., & Beunen, G. (1996). Matching of opponents in youth sports." The child and adolescent athlete. In O. Bar-Or (Ed.), *The child and adolescent athlete* (pp. 202-213). Oxford: Blackwell Science Ltd.
- Malina, R. M., Dompier, T. P., Powell, J. W., Barron, M. J., & Moore, M. T. (2007). Validation of a noninvasive maturity estimate relative to skeletal age in youth football players. *Clinical Journal of Sport Medicine*, 17(5), 362-368.
- Malina, R. M., Eisenmann, J. C., Cumming, S. P., Ribeiro, B., & Aroso, J. (2004). Maturity-associated variation in the growth and functional capacities of youth football (soccer) players 13-15 years. *European Journal of Applied Physiology*, 91(5-6), 555-562. doi: 10.1007/s00421-003-0995-z
- Malina, R. M., Morano, P. J., Barron, M., Miller, S. J., & Cumming, S. P. (2005). Growth status and estimated growth rate of youth football players: A community-based study. *Clinical Journal of Sport Medicine*, 15(3), 125-132. doi: DOI 10.1097/01.jsm.0000164287.42066.63
- Malina, R. M., Morano, P. J., Barron, M. A., Miller, S. J., Cumming, S. P., & Kontos, A. P. (2006). Incidence and player risk factors for iInjury in youth football. *Clinical Journal of Sports Medicine*, 3, 214-222.

- Malina, R. M., Ribeiro, B., Aroso, J., & Cumming, S. P. (2007). Characteristics of youth soccer players aged 13-15 years classified by skill level. *British Journal of Sports Medicine*, 41(5), 290-295. doi: 10.1136/bjsm.2006.031294
- Malina, R. M., Rogol, A. D., Cumming, S. P., Silva, M. J. C. E., & Figueiredo, A. J. (2015). Biological maturation of youth athletes: assessment and implications. *British Journal of Sports Medicine*, 49(13), 852-859. doi: 10.1136/bjsports-2015-094623
- Malina, R. M., Silva, M. J. C. E., Figueiredo, A. J., Carling, C., & Beunen, G. P. (2012). Interrelationships among invasive and non-invasive indicators of biological maturation in adolescent male soccer players. *Journal of Sports Sciences*, 30(15), 1705-1717. doi: 10.1080/02640414.2011.639382
- Martindale, R., & Nash, C. (2013). Sport science relevance and application: Perceptions of UK coaches. *Journal of Sports Sciences*, 31(8), 807-819. doi: 10.1080/02640414.2012.754924
- Martindale, R. J. J., Collins, D., & Abraham, A. (2007). Effective talent development: The elite coach perspective in UK sport. *Journal of Applied Sport Psychology*, 19(2), 187-206. doi: 10.1080/10413200701188944
- Meylan, C., Cronin, J., Oliver, J., & Hughes, M. (2010). Talent identification in soccer: The role of maturity status on physical, physiological and technical characteristics. *International Journal of Sports Science & Coaching*, 5(4), 571-592. doi: 10.1260/1747-9541.5.4.571
- Savage, J., Collins, D., & Cruickshank, A. (2016). Exploring traumas in the development of talent: What are they, what do they do, and what do they require? *Journal of Applied Sport Psychology*, 29, 1-17.
- Seefeldt, V. (1981). Equating children for sports competition: Some common problems and suggested solutions. *Motor Development Theory into Practice*, 3, 13-22.

- Simonton, D. K. (1999). Talent and its development: An emergenic and epigenetic model. *Psychological Review*, 106(3), 435-457. doi: Doi 10.1037/0033-295x.106.3.435
- Sparkes, A. C., & Smith, B. (2013). *Qualitative research methods in sport, exercise and health: From process to product*. London: Routledge.
- Sweet, S. L., Dompier, T. P., Stoneberg, K. N., & Ragan, B. G. (2002). Self-reported parent stature is acceptable in estimates of maturity status in youth soccer players. *Journal of Athletic Training*, 4(2), S-129.
- Till, K., Cogley, S., Wattie, N., O'Hara, J., Cooke, C., & Chapman, C. (2010). The prevalence, influential factors and mechanisms of relative age effects in UK Rugby League. *Scandinavian Journal of Medicine & Science in Sports*, 20(2), 320-329. doi: 10.1111/j.1600-0838.2009.00884.x
- Toering, T. T., Elferink-Gemser, M. T., Jordet, G., & Visscher, C. (2009). Self-regulation and performance level of elite and non-elite youth soccer players. *Journal of Sports Sciences*, 27(14), 1509-1517. doi: 10.1080/02640410903369919
- Tucker, R., Raftery, M., & Verhagen, E. (2016). Injury risk and tackle ban in youth Rugby Union: Evaluating the evidence and searching for targeted, effective interventions. *British Journal of Sports Medicine Online*, 0, 1-6. doi: doi:10.1136/bjsports-2016-096322
- Vaeyens, R., Malina, R. M., Janssens, M., Van Renterghem, B., Bourgois, J., Vrijens, J., et al. (2006). A multidisciplinary selection model for youth soccer: the Ghent Youth Soccer Project. *British Journal of Sports Medicine*, 40(11), 928-934. doi: 10.1136/bjsm.2006.029652
- Wills, W. J. (2012). Using spoken and written qualitative methods to explore children's and young people's food and eating practices. *Sociological Research Online*, 17(3). doi: Artn 16 10.5153/Sro.2670

World Rugby. (2016). Weight consideration guideline. Retrieved from World Rugby
<http://playerwelfare.worldrugby.org/?subsection=64>

Zuber, C., Zibung, M., & Conzelmann, A. (2016). Holistic patterns as an instrument for predicting the performance of promising young soccer players - A 3-Years Longitudinal Study. *Frontiers in Psychology*, 7. doi: Artn 1088 10.3389/Fpsyg.2016.01088